New Mexico Math Pathways Taskforce Report

July 2016

New Mexico Higher Education Department

Introduction

In April 2015 New Mexico faculty, Dana Center staff, and New Mexico Higher Education (NMHED) co-presented the need for better math pathways statewide. Faculty from 6 institutions (New Mexico State University, New Mexico Highlands University, Dine College, Eastern New Mexico University, El Paso Community College, and San Juan College) participated in a preliminary math task force. The task force collaborated to help facilitate speakers and participants at the New Mexico Math Summit hosted by NMHED in Santa Fe October 2, 2015. At this summit a number of math faculty statewide expressed a desire to learn more about pathways including alternatives to college algebra.

In January 2016, New Mexico Higher Education Department (NMHED) established a statewide Mathematics Task Force in order to determine the need for statewide alternative math pathways and make recommendations for implementation. It was important to stakeholders that a new system of pathways for college mathematics was developed that did not lower the rigor of mathematics at each of its institutions. The task force was given a deadline of July 15, 2016.

Per the request of the Secretary of NMHED, Dr. Barbara Damron, presidents of each institution of higher education in the state nominated members to the New Mexico Math Pathways Task Force (See Appendix). A taskforce of faculty from each higher education sector in the state was convened. The work was carried out under the leadership of Alicia O'Brien, Math Department Chair of San Juan College, under the advisement of Senior Policy Analyst Bridgette Noonen.

Background

Within New Mexico there are institutional math pathways present, however none of them are currently aligned to scale. In general, state institutions possess a Liberal Arts pathway, a Statistics pathway, and a STEM math pathway. In light of this, it may be beneficial to follow national trends and develop statewide math pathways that transfer institutions. In 2010 the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine determined that in order to acquire a highly qualified workforce, mathematics must be a focus for institutions of higher education. The data demonstrate that mathematics may be a considerable stumbling block for students, resulting in longer times to degree completion or students abandoning their degree program altogether.

On average 46% of students beginning in 2-year institutions in New Mexico require remediation in math. In New Mexico's 4-year non-flagship institutions 40% of students begin in remedial math. Moreover, of the students who enrolled fulltime in an associates program (HED, 2009) 2.31% graduated in 2 years; in 2009 5.51% graduated in 3 years and in 2014 3% graduated in 3

years; 14.4% of students graduated in 4 years. New Mexico's graduation rate for bachelor's degrees in 2006-2007 was 14%. In 2014 17% of bachelor's students graduated in 6 years and 45% of students in a research institution graduated in 6 years. This data suggests that there is a large amount of improvement that can be made in New Mexico and that large numbers of students in remedial math play a part in current graduation rates. Focusing on alternative math pathways will improve state graduation rates and will better serve our students by providing relevant math courses that keep students in college until degree completion. The nuances of how these statistics directly relate to alternative math pathways is discussed below.

Fifty years ago, students who took math for their degree plans were preparing for engineering or science careers. At that time many majors outside of science and engineering had no mathematics requirements at all. We do not recommend this course of action; however, currently all students need a deeper understanding of mathematics and how to apply it in a variety of career and personal situations. All students also need sufficient knowledge of statistics and data analysis in order to manage political, civic, and physical structures (University System of Georgia, 2013). We recommend all students of every major to study mathematics in a form that is most useful to them.

Many labor economists recognize that both college completion and mathematical knowledge and skills, are significantly correlated to upward economic and social mobility (Greenstone, Looney, Patashnik, & Yu, 2013). Aligning New Mexico's mathematics curriculum therefore will serve to increase access for students who have previously had little success. Moreover, many accomplished students with declared STEM majors leave college without completing a degree, strong evidence for redesigning math curriculum for STEM fields as well as non-STEM fields (Arcidiacono, Aucejo, & Hotz, 2016).

What is the "Right Math"?

College algebra and traditional math sequences were designed in the 1950s to prepare students for calculus. The majority of students, however, are in majors that do not require calculus. According to Kazis and Cullinane (2015) there is significant agreement among universities that students' majors must be aligned to math relevant to that major in order to graduate career ready students. Requiring math that does not prepare students for the work force is a disservice to them. In New Mexico, large numbers of students continue to take an algebra based course that they will not apply on the job once they graduate. The Mathematical Association of America reports (2011):

> *Unfortunately, there is often a serious mismatch between the original rationale for a college algebra requirement and the actual needs of students who take the course. A critically important task for mathematics sciences departments at institutions with college algebra requirements is to clarify the rationale for requirements, determine the needs of students, and ensure that department's courses are aligned with these findings.*

This implies that for non-STEM majors there may be a better mathematics requirement that is more relevant to students and better prepares students for the workforce after graduation. Recent research demonstrated that remedial math students put into a statistics course rather algebra based courses have a significantly higher pass rate (Logue, Watanabe-Rose, & Douglas, 2016). The reason for this, is that most students fail the remedial elementary algebra due to lack of interest because it does not seem relevant to their future career. However, if they take a quantitative reasoning course that closely applies to their major, they see the relevance of the math and are motivated to pass the course because it is connected to their future career.

Recommendations

The recommendations made within this report reflect the consensus of the Math Pathways Task Force in the majority of cases. Cases that deviate from consensus of the group will be noted. Recommendations apply to all of New Mexico's higher education institutions. The task force asserts that it is important to consider what all campuses are currently doing in terms of pathways and honor these pathways in addition to allowing time for campuses that have limited pathways to pilot new pathways. Equally important is to bring pathways statewide to scale. The recommendations outlined below seek to do that.

1. Meet with degree granting departments at each institution and align 100 and 200 level courses with the students' academic program of study. In particular, a three prong model should be used that aligns with students' degree program: a. Statistics Pathway; b. Quantitative Reasoning Pathway; c. College Algebra Pathway.
2. Develop a holistic placement procedure for students. This is also addressed by the NM HED Development Education Committee.
3. Cultivate an advising process that supports these pathways: Statistics Pathway, Quantitative Reasoning Pathway, and College Algebra Pathway.
4. Build on existing math pathways at each institution.

Recommendation 1: *Meet with degree granting departments at each institution and align 100 and 200 level courses with the students' academic program of study.*

To better serve students in non-STEM fields it is important to create math pathways that are relevant to students' majors. NMHED should work with higher education institutions to develop pathways specific to students' programs of study. For example, statistics for students in the social sciences and health fields; quantitative reasoning for students in the liberal arts and fine arts; and college algebra leading to the calculus sequence for students in STEM majors. Requirements for non-STEM majors should be aligned with the recommendations from mathematics and discipline professional

associations that mathematics course sequences for those programs be non-algebraically intensive (Kazis, & Cullinane, 2015).

In particular, a committee should be convened to create comprehensive Quantitative Reasoning course objectives statewide. Currently, seven of New Mexico's higher education institutions have a defined set of Quantitative Reasoning objectives. We recommend having a task force that reviews the student learning outcomes of each of these Quantitative Reasoning courses to ensure the rigor of at-scale alternative pathways. Additionally, the taskforce recommends a statistics pathway applicable to health sciences and nursing.

New Mexico's higher education institutions should ensure the articulation of pathways for mathematics to programs of study so that students learn the mathematical content applicable and relevant to their majors. There are currently two primary mathematics pathways: the calculus strand for STEM majors which includes intermediate and college algebra, and a math course for non-STEM majors. These pathways include liberal arts math courses, introductory statistics, and conceptual mathematics. Most students enrolled in New Mexico's higher education institutions now take Intermediate Algebra as their entry-level mathematics course. Intermediate Algebra is the prerequisite for College Algebra, which was designed explicitly to meet the needs of students who are preparing to take the Calculus strand of courses. Most students in non-STEM majors would be better served by enrolling in a Quantitative Reasoning course (often called Math for Liberal Arts Majors) or Statistics course in which students gain financial literacy and learn how to apply basic statistics, the skills vital in preparing them for responsible citizenship. Based on the outlined objectives that seven of our institutions have in common, it should be possible to develop an appropriate, mathematically rigorous Quantitative Reasoning course to serve a broad array of non-STEM programs of study.

For some 2-year institutions it is difficult to fill the classes that would be a better alternative than College Algebra; some of the reasons contributing to this challenge include: (1) students initially selecting a major like engineering or nursing that they are not necessarily suited to and then running out of financial aid resulting in the student defaulting to a liberal arts degree in order to complete a degree and fulfill financial aid requirements; (2) conversely, some advisors recommend college algebra because they are concerned that non-STEM students might change their mind and pursue a STEM major; and (3) the misperception by many math faculty across the state that Quantitative Reasoning lacks appropriate rigor. In order to increase statewide on time graduation rates, it is essential that the practice of using Intermediate Algebra as a proxy for general quantitative ability be reserved exclusively for STEM majors. Data collected by the taskforce indicate that placement in Intermediate Algebra for the above reasons is a major contributor to student failure and attrition of students within higher education as a whole. Furthermore, the broad audience in Intermediate Algebra makes it challenging to organize this important course as a true stepping stone to Calculus.

The task force recognizes that normative mathematics pathways should be designed to serve the vast majority of students in their pursuit of a clear program of study.

According to the University of New Mexico Task Force members, the quantitative skills necessary to succeed in core math are reviewed and expanded in the MaLL (Math Learning Lab). These skills are divided into three 1 credit courses called Math 101, 102 and 103. We recognize that the necessary preparation is different for students who will take Quantitative Reasoning (Math 129) and Introduction to Statistics (Stat 145) than for those who will go on to College Algebra, Pre-Calculus and Calculus. Student who will take Math 129 or Stat 145 take only Math 101 and 102 while students on the path to College Algebra (Math 121) also take Math 103. This allows quicker progress to the math courses needed by humanities and social sciences majors, but also allows an easy switch (adding only Math 103) if students wish to pursue a different path. Students who will take Math 129 or Stat 145 as their required math are not advised to take College Algebra.

A Quantitative Reasoning committee should be charged with developing a framework and set of guiding objectives for a statewide Quantitative Reasoning course used as the primary math for non-STEM majors. New Mexico colleges should be supported in developing a common Quantitative Reasoning course that supports the needs of each unique campus population.

Recommendation 2: *Develop a holistic placement procedure for students.*

The New Mexico Developmental Education Task force is currently working on a placement matrix that utilizes both ACT scores and student GPA rather than Accuplacer scores alone. We support this effort, but recommend that a similar matrix be created for students that do not take ACT, particularly for the state's 2-year institutions. This could be developed through the use of Accuplacer scores aligned to GPA. Non-traditional students that have been out of school for more than 5 years would be automatically placed into a co-requisite model for support upon entrance into their first year of mathematics. It would be beneficial from a collaborative standpoint to have all New Mexico institutions work together to identify ways to shorten each math pathway. The goal of the collaboration would be to identify a math pathway that would enable mathematically deficient students enrolled in a New Mexico college to complete a degree bearing gateway math course in one semester. UNM is currently considering ALEKs, Accuplacer, and GPA as a means for placement.

Recommendation 3: *Cultivate an advising process that supports a: Statistics Pathway, Quantitative Reasoning Pathway, and College Algebra Pathway.*

Northern New Mexico College, Eastern New Mexico University, and San Juan College all have unique issues regarding advising and how this impacts mathematics pathways that need to be shared at the state level and compared to the remaining New Mexico institutions of higher learning.

At Northern New Mexico College (NNMC) the Quantitative Reasoning course (MATH 151 Conceptual Math) has not been taught for some time due to very low student enrollment. Most non-STEM students take either MATH 150 College Algebra or MATH 145 Intro to Probability & Statistics, even when Conceptual math is being offered. The biggest problem has been outreach and building it into the culture. Flyers and emails advertising the course are of limited value in course recruitment, we recommend more in-person efforts. Also, there is a concern about course transferability. This issue will be resolved after the Common Course Numbering Committee establishes the state-wide course alignment. Faculty have expressed a desire to further develop a Quantitative Reasoning course to fit the New Mexico math pathways model outlined in this report. As a following step, we recommend more training and outreach to explain what Quantitative Reasoning (QR) course is and who can take it. Advisors and students do not have an appropriate level of awareness of what a QR course is and why and when someone should take it. We also recommend the course name be changed from Conceptual Math to Quantitative Reasoning or Math for Liberal Arts Majors. Tables 1, 2, and 3 illustrate the above described practices.

Table 1. MATH 151 Conceptual Math
College of Arts and Sciences
Dept. of Fine Arts
Art (AA)
Dance (AA)
Film and Digital Media Arts (AA)
Music (AA)
Southwest Heritage Arts (AA)
Technical Theatre (AA)
Theatre (AA)
Music (BA)
Dept. of Humanities, Social Sciences & Language and Letters
Integrated Studies/Crime & Justice Studies (BAIS)*
Integrated Studies/Humanities (BAIS)*
Integrated Studies/Pueblo Indian Studies (BAIS)*
Liberal Arts (AA)
Pueblo Indian Studies (AA)
* can take MATH 150 instead of MATH 151

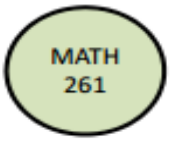
Table 2. MATH 150 College Algebra
College of Arts and Sciences
Dept. of Biology, Chemistry & Environmental Sciences
Biology (BS)**
Biology (AS)
Chemistry (AS)
Environmental Science (BS)**
Environmental Science (AS)
Radiation Protection (AAS)**
** need to take both MATH 145 and MATH 150
Dept. of Math and Physical Sciences
Mathematics (BS)
Mathematics (AS)
College of Business and Administration
Business Administration (AA)***
Business Administration/Accounting, Management, Project Management (BBA)***
*** can take MATH 150 and either MATH 145 or business stats, OR MATH 145 and business stats
College of Education
Early Childhood Education (AA)
Elementary Education (AA)
Elementary Education (BA)
College of Engineering and Technology
Pre-Engineering (AEng)
Electromechanical Engineering Technology (BEng)
Information Engineering Technology (BEng)**
Mechanical Engineering Solar Energy (Beng)**
** need to take both MATH 145 and MATH 150

Table 3. MATH 145 Intro to Probability & Statistics
College of Arts and Sciences
Dept. of Humanities, Social Sciences & Language and Letters
Integrated Studies/Psychology (BAIS)
Criminal Justice (AA)
General Psychology (AA)
Police Science (AAS)
Substance Abuse Counselor (AA)
Dept. of Biology, Chemistry & Environmental Sciences
Biology (BS)**
Environmental Science (BS)**
Radiation Protection (AAS)**
**need both MATH 145 and MATH 150
College of Business and Administration
Business Administration (AA)***
Business Administration/Accounting, Management, Project Management (BBA)***
*** can take MATH 150 and either MATH 145 or business stats
College of Education
Elementary Education (BA)
need math 150 plus math 145 OR trig OR calculus
College of Engineering and Technology
Information Engineering Technology (AEng)
Software Engineering (AEng)
Information Engineering Technology (BEng)**
Mechanical Engineering Solar Energy (Beng)**
**need both MATH 145 and MATH 150
College of Nursing and Health Sciences
Nursing - RN to BSN (BSN)

At Eastern New Mexico University (ENMU) If a student begins as an undeclared major at ENMU they are not placed in a math course. If the student declares a major the student is placed according to the following placement matrix:

2015-2017 MATH Placement Matrix

Elementary Education



Elementary Education Students *should be enrolled in MATH 261. MATH 261 has no pre-requisite.*

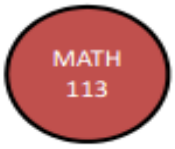
Early Childhood Education

Emphasis	Course Successfully Completed or Placed Beyond	Next Course	Subsequent Course(s)
Birth - PreK	None	MATH 113	MATH 261
Birth - PreK	MATH 106	MATH 113	Choose one from MATH 261 or STAT 213
Birth - PreK	MATH 107	MATH 113	Choose one from MATH 261, STAT 213, or MATH 119
Birth - PreK	MATH 104	MATH 119	Choose one from MATH 113, MATH 261, or STAT 213
NOTE: The Birth – PreK emphasis requires 6 credits from MATH 113**, MATH 119*, MATH 261**, or STAT 213*			

PreK – Grade 3	None	MATH 106	STAT 213, MATH 113, and MATH 261
PreK – Grade 3	MATH 106	STAT 213	MATH 113 and MATH 261
PreK – Grade 3	MATH 107	MATH 113	Choose two from MATH 261, STAT 213, or MATH 119
PreK – Grade 3	MATH 104	MATH 119	Choose two from MATH 113, MATH 261, or STAT 213
NOTE: The PreK – Grade 3 emphasis requires 9 credits from MATH 113**, MATH 119*, MATH 261**, or STAT 213*			

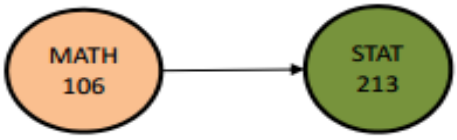
*See the tables below for placement into STAT 213 or MATH 119.
**MATH 113 and MATH 261 have no prerequisites.

Majors not Requiring MATH 119 or STAT 213



Students interested in Majors that do not require MATH 119 or STAT 213 *should take MATH 113. MATH 113 has no pre-requisite.*

Majors Requiring STAT 213 but not MATH 119



COMPASS Algebra Subtest	Placement
65 or lower	MATH 106
66 or higher	STAT 213

Majors

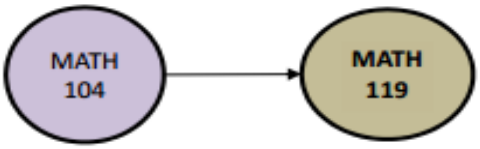
ACT Math	SAT Math	No GPA or 2.00 to 3.00	GPA 3.01 to 3.50	GPA 3.51 and up
11 – 13	260 – 340	MATH 106	MATH 106	MATH 106
14 – 20	350 – 530	MATH 106	MATH 106	STAT 213
21 – 22	540 – 560	MATH 106	STAT 213	STAT 213
23 and above	570 and above	STAT 213	STAT 213	STAT 213

2015-2017 MATH Placement Matrix

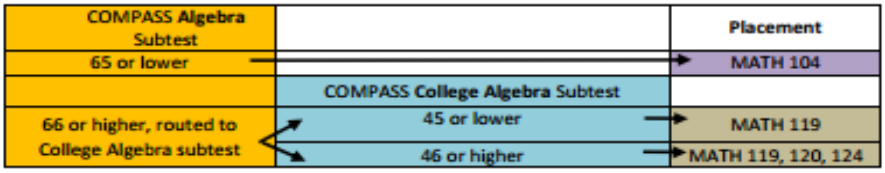
Requiring STAT 213 AND Requiring MATH 119

Students who need both MATH 119 and STAT 213 should initially follow the placement for MATH 119. Once MATH 119 is successfully completed, the student should then go directly to STAT 213 (MATH 106 is not required if MATH 119 has been successfully completed).

Majors in Sciences, Technology, Engineering, Math, and College of Business (Any degrees requiring MATH 119.)



ACT Math	SAT Math	No GPA or 2.00 to 3.00	GPA 3.01 and up
11 – 13	260 – 320	MATH 104	MATH 104
14 – 22	350 - 560	MATH 104	MATH 119
23 and above	570 and above	MATH 119	MATH 119



Transitions from Former ENMU Courses and Transfer Courses to Current Courses

Track	Course Successfully Completed	Next Course	Subsequent Course
Statistics STAT 213	MATH 094	MATH 106	STAT 213
Statistics STAT 213	MATH 097	MATH 106	STAT 213
Statistics STAT 213	MATH 106	STAT 213	
Statistics STAT 213	MATH 107	STAT 213	
College Algebra MATH 119	MATH 094	MATH 104	MATH 119
College Algebra MATH 119	MATH 097	MATH 104	MATH 119
College Algebra MATH 119	MATH 107	MATH 119	

Students with High Scores on ACT/SAT:

- Students with a MATH ACT of 24 or higher (SAT MATH of 600 or higher) are qualified to take MATH 120 (Trigonometry) with no prerequisite.
- Students with a MATH ACT of 26 or higher (SAT MATH of 640 or higher) are qualified to take MATH124 (Calculus I) or MATH 215 (Survey of Calculus) with no prerequisite.
- *NOTE: Please contact your advisor or the chair of the Department of Mathematical Sciences if you are not certain about which math you need to take.*

When the advising process starts each semester, the chair of the mathematics department at ENMU sends an e-mail to the chairs of each department in the College of Liberal Arts and Sciences, and to each of the deans of the other colleges. The e-mail is a reminder of the recommendations for placing students in their mathematics courses. We believe that this is a good model and that together with

in-person meetings with the advisors and departmental chairs these practices should improve correct placement of students in math courses and ultimately the on-time graduation rates.

At San Juan College a high number of students tend to begin their studies trying to get into the nursing program. This requires them to take intermediate and college algebra. When they do not get into the program, they then change their major to LBAS in order to graduate with a degree. This generates large numbers of students that show up as LBAS majors taking STEM related math. In addition, this disproportionately lowers the number of students that take an LBAS math course dramatically because a majority of our students begin as engineering or health science majors. This is also a financial aid issue. If the student graduates with an associate's degree, then financial aid will fund a new degree in a different area so it rewards the student to finish the LBAS immediately and start a new degree program. Another culprit are students that jump an entire meta-major because financial aid will drop these students when they change their majors. For this reason, we recommend investigating the way in which financial aid is dispersed and how this impacts student advisement.

At UNM, advisors are trained and updated every year in the pathways to Quantitative Reasoning, Statistics and Calculus. First, students are strongly advised to take placement tests. We recognize that many students have taken additional math after the ACT tests. Since the placement tests can only place students up a level in math, they are no risk for the students. Second, any student who thinks they know their major works with an advisor in the major. These advisors know the appropriate math sequences. And, for any student who starts in the MaLL, Math 101 and 102 are the pathway for all students.

Finally, At NMSU, intermediate algebra is also a pre-requisite for our stat class and math for elementary education majors. This requirement is fairly new and strongly desired by the various departments.

Recommendation 4: *Build on Existing Institutional Math Pathways.*

This report illustrates that all institutions within New Mexico HED possess some form of math pathways. It is the recommendation of this task force that these commonalities be built upon to form a more cohesive statewide system of pathways. This will take considerable time due to the fact that many institutions have a wide variety of courses and objectives within their current pathways. For example, courses at one institution do not match directly with courses at another. Although there are often similarities that allow for transfer, it would better serve students to increase matching among course objectives throughout the state. This would serve to decrease gaps in student learning as they transfer from one institution to the next. We recommend a year long process of creating more compatible course objectives among all New Mexico institutions of higher education. This work should be informed by the findings of the Common Course Numbering Task Force.

Appendix I. References

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